Classroom factors influencing students' beliefs about success and failure in mathematics

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Abstract

Models explaining gender differences in mathematics learning outcomes incorporate affective variables including students' attributional styles. In the present study, four grade 7 students in two different classrooms were observed as they engaged in mathematics activities. Behaviours reflecting attributions for success and failure were monitored and compared to conventional measures of the students' relevant beliefs. Classroom factors which might influence these beliefs were identified and partial explanations for some of the gender differences noted were inferred. Implications of the findings are discussed.

Introduction

Gender differences in mathematics learning outcomes persist in Australia and elsewhere. In particular, a greater proportion of males than females studies the most demanding mathematics courses when they become optional (Leder & Forgasz, 1992). As students progress through school, males often outperform females on the most cognitively demanding mathematical tasks, especially those involving timed tests (Fennema & Peterson, 1985; Leder, 1992). Several models explaining these gender differences incorporate affective variables including students' beliefs about the causes of their successes and failures in mathematics (see Leder, 1992).

The Mathematics Attribution Scales [MAtS] (Fennema, Wolleat & Pedro, 1979) were developed from Weiner's (1974) general theory of causal attributions and have been used extensively. Compared to males, females are found less likely to attribute success in mathematics to ability and failure to lack of effort, and more likely to attribute success to effort and failure to lack of ability or to an external factor (Kloosterman, 1993). To varying degrees, these beliefs can be shaped by external factors: society's attitudes, parents' beliefs, the peer group, and teachers.

Fennema and Peterson's (1985) Autonomous Learning Behavior [ALB] model links external/societal influences (including the classroom), a set of internal beliefs (including attributional style), and ALB-participation (choosing to do high-level tasks, working independently, persisting, and achieving success at them) to gender differences in achievement on cognitively demanding mathematical tasks. The classroom factors claimed to influence students' beliefs and ALB-participation are teachers' beliefs, actions and the learning activities they encourage.

The results discussed in this paper were part of a larger study in which the relationships between a range of students' beliefs and classroom factors were investigated at two levels. A large scale survey revealed that students who felt they were active participants in classrooms where investigative skills were encouraged and who perceived their teachers to be interested in them as individuals also held positive beliefs about themselves as learners of mathematics. To explore the relationship further, in-depth studies of two classrooms were conducted. Reported here are the classroom factors that were identified which might influence students' attributions for success and failure in mathematics.

Participants

One class of grade 7 mathematics students from two coeducational secondary schools in metropolitan Melbourne (Valley View SC and Seaside campus of Bayview SC) participated in the study. Two males and two females in each class were targeted for intensive study.

Methods and instruments

Data were gathered from several sources: self-report questionnaires from class cohorts, interviews with targeted students, information about students from teachers, and videotaped records of fourteen sequential mathematics lessons at Valley View and eleven at Seaside. During the monitored periods, students were engaged in various mathematical activities in whole class, paired and cooperative small group learning settings. In at least four lessons students worked cooperatively. The videocamera was focussed on the four targeted students for paired and small group work. Behaviours from which students' beliefs could be inferred were monitored. The lesson episodes in which these behaviours were manifest and the relevant circumstances were examined. Comparisons were made between observed behaviours and beliefs expressed in the self-report data. Classroom factors which might explain consistencies and inconsistencies in the beliefs and behaviours of individuals and among class cohorts were sought.

A summary of the two grade 7 classes and of the observed lessons is shown on Table 1.

The following data sources were relevant to the results reported in this paper:

1. Beliefs about success and failure in mathematics.

With minor modifications to item wording, the Mathematics Attribution Scales [MAtS] (Fennema, Wolleat & Pedro, 1979) were administered to both class cohorts. Details of the MAtS are summarised below.

MAtS: 4 success (S/) and 4 failure (F/) items. 4 statements follow each item stem, one related to each of: ability, effort, task, and environmental factors.

Scoring: 5-point Likert-type scales (strongly agree to strongly disagree). 4 subscales: item scores summed (score range: 4 to 20)

Sample item: Success item stem

You got the results you wanted for the term in maths

Ability: You are good at maths

Effort: You spent a lot of time studying maths

Task: The work covered in class was easy

Environment: The teacher is good at explaining maths

2. Interviews

The four targeted students in each class were interviewed after the monitored periods.

3. Videotaped records of lessons

Transcripts were derived from the videotapes of the mathematics lessons in each class. Operational definitions were developed for classroom behaviours from which students' beliefs could be inferred. The definitions of success and failure attributed to ability is shown below. A transcript extract from Valley View is shown as an example.

Attributions for success/failure: verbal statement or action suggesting that success/failure in mathematics may be attributable to ability, effort, task or the environment.

R: I've got a tired brain, OK?

C: Really, I didn't know you had any brains.

Ability: Having (lacking) skill, talent, or being (un)able to understand an idea.

C: attributes R with lack of ability and R indirectly attributes himself with ability.

Table 1 Summaries of the observed classrooms

	Valley View SC	*Seaside campus*
Class size	*26 (12M, 14F)*	*23 (12M, 11F)*
Teacher	*TD (male): experienced, first year at the school*	*SE (female): many years at the school.*
Targeted students	*Cara and Jill (F); Ron and Stan (M)*	*Jane and Yin (F); Joe and Milo (M)*
Classroom atmosphere	*Noisy. Frequent off-task behaviours. TD re-directed attention to task; rarely raised his voice or disciplined individuals.*	*Fairly relaxed. Students well-behaved and generally task-oriented. Followed SE's directions quickly and with little fuss.*
Sequence of lessons	*Targeted students sat together. L1 1-2: bar graphs. WCI (in pairs for part of L 2).*	*Targeted students sat together for CSG, some P activities, sometimes for WCI.*
***Valley View:** 14 lessons observed. Topic: Chance and data*	*L 3: line plots. WCI (some individual and paired work)* *L 4-7: 'Scrabble project'. CSG* *L 8-9: 'Football simulation'. P/CSG*	*L 1: class test. WCI* *L 2: 'Backtracking' and 'What's my rule?'. WCI followed by CSG* *L 3: Cartesian plane 'Bingo'. WCI* *L 4: Cartesian plane. CSG* *L 5: 'Rollers activity'. WCI then CSG*
***Seaside campus:** 11 lessons observed Topic: Algebra*	*L 10-11: 'Basketball simulation'. P/CSG* *L 12-13: 'Horse-racing simulation'. CSG* *L 14: Revision. WCI*	*L6 Cartesian plane 'role play'. WCI* *L 7: Cartesian plane - 'Battleships'. P* *L 8: Class test. WCI* *L 9: Index laws. CSGL 10-11: Algebra - card games. P*
Interpersonal interactions among targeted students	*Cara and Jill were friends, as were Ron and Stan. The boys were generally uncooperative, rude, and often taunted the girls.*	*The four had all attended the same primary school and knew each other well. They worked well as a small group and were generally respectful of one another.*

Key to abbreviations: L=lesson, WCI=whole class instruction, P=paired activity, CSG=cooperative small group

Results and discussion

The results from the self-report data are summarised on Table 2. Common trends among the male and female cohorts in the two classes are evident. Compared to their male counterparts, the female cohorts attributed:

* success to ability to a lesser extent
* failure to lack of ability to a greater extent
* failure to lack of effort to a lesser extent
* success and failure to environmental factors to a lesser extent (differences negligible at Seaside, much more pronounced at Valley View)

The gender differences noted for the first three variables replicate those frequently reported in the literature. The pattern of gender differences for the targeted group at Valley View was similar to the common trends noted for the two classes (see Table 3).

Table 2 Means for attribution variables for Valley View SC and Seaside campus, and scores for the targeted students

		Valley View SC					Seaside campus				
		Class	Females		Males		Class	Females		Males	
Variable		*mean*	*C*	*J*	*R*	*S*	*mean*	*Ja*	*Y*	*Jo*	*M*
S/ABILITY	M	14.36	14	10[1]	16	15	14.33	18	12	16	12
	F	13.15					12.56				
S/EFFORT	M	15.64	16	15	9	15	13.58	18	16	14	12
	F	14.92					15.35				
S/TASK	M	14.36	15	13	16	15	13.25	19	16	10	11
	F	13.38					13.82				
S/ENVIR	M	16.27**[2]	16	13	15	15	15.50	17	16	15	16
	F	14.54					15.45				
F/ABILITY	M	12.36	12	8	14	14	12.08	8	14	8	12
	F	12.85					13.00				
F/EFFORT	M	13.91	12	9	14	16	13.58**	10	12	11	12
	F	11.92					11.09				
F/TASK	M	13.82	15	13	16	13	14.08	10	16	8	12
	F	15.46					14.00				
F/ENVIR	M	10.27*	8	5	9	12	10.67	9	11	9	7
	F	9.69					10.64				

1 For each variable, the double underlined score(s) indicates the highest scoring targeted student(s) and the single underlined score(s) indicates the lowest scoring targeted student(s)
*2 Significant within class gender differences: **=p<.05, *=p<.1*

Table 3 Gender differences among the two groups of targeted students

Valley View	*Seaside campus*
Compared to Ron and Stan, Cara and Jill attributed:	*Compared to Joe and Milo, Jane and Yin attributed:*
* *success to ability to a lesser extent*	* *success to effort and to task to a greater extent*
* *success to effort to a greater extent (NB. equal scores for Jill and Stan)*	
* *failure to lack of ability, lack of effort, and environmental factors to a lesser extent*	

Classroom observations enabled explanations for variations in beliefs among the targeted individuals and for the class cohorts to be inferred. The classroom factors implicated are discussed below. Space constraints allow only a selection of typical lesson episodes from a limited number of lessons from both classrooms to illustrate relevant attribution-related behaviours. See Table 1 to put the lessons into context.

During the `Scrabble project' (Valley View), there were marked gender differences in task engagement among the four targeted students. Cara and Jill were task-oriented. Ron's and Stan's `lack of effort' was obvious as shown by the lesson episode below:

Lesson 7: 5.11-6.35. C and J discuss the border for the project sheet; R and S fool around. At 5.27 S provokingly complains `This is really very unfair on us'. C retorts `Are you being worked too hard?'. S nods. C: `Gee, we did bloomin' everything'. At 5.43 C and J discuss colours to use and border size for the project sheet; S and R do nothing.

Observations showed that Jill and Cara did most of the work on the `Scrabble project'. The girls were frustrated by the boys' lack of effort and raised the issue several times with the boys and with TD. In return the boys were offensive and insulting, and TD was not fully supportive. TD may have been mislead about the extent of the boys' contributions. Ron made persistent demands for explanations and the boys were involved, although reluctantly, in deriving the raw data for the project. Since each group member was assigned the same `group' grade, the boys' work avoidance tactics (lack of effort) were `rewarded'. Cara and Jill were not taken in by the boys' tactics, however. At interview Jill made this clear. She also recognised that without the girls' efforts, the project would not have been completed:

S and R, they were the two boys with us. They wouldn't do anything. When we told TD, they just said `we don't understand'. And then he would explain it. Every time that they wouldn't do any work, they'd say `because we don't understand it'. And TD had explained it all, and whenever he'd finished explaining, they said they understood. And C and I got really angry because we did the whole project. And the boys just sat there expecting us to do all the work, and we did. But we didn't really have a choice, otherwise if we didn't do it, it wouldn't get done.

Ron and Stan considered lack of effort a more likely cause for failure in mathematics than did the girls (Table 2). Since their efforts during the `Scrabble project' were minimal compared to the girls', this gender difference has a contextual base. The students' grade for the project was good. Had the project been unsuccessful, Ron and Stan may well have claimed that lack of effort had been a contributing factor; conceivably, the girls would attribute the failure to other causes.

Classroom observations at Valley View provided plausible explanations for gender differences in effort attributions and were supported more subtly at Seaside. More frequently than females, males made statements setting up situations so that potential failure was attributed to lack of effort (or carelessness). Formal assessment was often associated. In Example 1 below, Milo tried to attribute his potential failure to question difficulty, anxiety and memory loss. Jane concurred about task difficulty; Joe attributed his failure to a `stupid mistake' (carelessness). Comments made by SE may have re-inforced males' beliefs that failures were attributable to lack of effort and not to lack of ability. As shown in Example 2, a boy who scored 3 out of 10 for a test was able to excuse his errors with suggestions of carelessness (lack of effort).

EXAMPLE 1

Lesson 9: 12.40 - 13.36

SE returns Y's test.

M: Is that the maths test? (Ja nods) (Takes deep breath) I did badly.

Ja: Oh, no.

M: I got all nervous, and the questions were real hard.

Ja: Yes. Oh (holding head and shaking it).

M: Jo didn't think they were real hard.

Jo: They weren't really bad.

M: I forgot how to do percentages.

Jo: (unclear).. I made this stupid mistake, right. 4 + 1 (SE brings M his test) and I did something...

Ja: Did you do OK?

Jo: Oh, he got all of them right.

M: 46-1/2 out of 67.

Ja: Shh.. (also gesticulates) You don't tell people.

M: It doesn't matter.

EXAMPLE 2

Lesson 8: 36.50-end of lesson

SE: T? Now T, let's have a look at yours. Where are your 10 quick questions? Is this it?

T: Yes. I've got stupid mistakes.

SE: Well that's a mark there which you don't look like you've got...

T: y too, but I forgot to put the minus sign.

SE: and you've got... the x value comes first T, not the y.

T: Yes.

SE: So where's the start, 1 is wrong.

T: Yes, I know that.

SE: 2 is right.

T: Right.

SE: Is right, so there's a mark. 3 is right . there's a mark. That's 2. There's half a mark.

T: I forgot to put the...

SE: You didn't have those. There's a half a mark. That's 2´. 5 is wrong.

T: I know. I forgot the minus..

SE: 6 is right, so that's 3´. 7, 8, 9 . no, and 10. So, yes, 3´.

At Seaside, behaviours related to success and failure attributions often accompanied competitive activities. Exchanges between Yin and SE (Lesson 3 - shown below) suggested that both attributed her win at `Bingo' to luck. Milo and Joe attributed it to `cheating'. More than luck was involved in her success. The videotape showed that several students could not plot the ordered pairs which had been called out quickly. Perhaps they could not keep up or did not have had the necessary skills.

Lesson 3: 33.23 - 34.55

SE asks Y to call out the ordered pairs she has marked and for the class to check. All check out.

At 34.42 M and Jo turn around to Y (who is sitting behind them). M says `You cheated! You put them down...'. SE tells Y to come for a `chocky surprise' at recess.

Lesson 3: 37.57 - 38.59

SE (to Y): Y, I think it might be your week to take out a Tatts [lottery] ticket.

Y: I won $3 last week.

SE: Did you? Oh, you're on a lucky streak then, aren't you?

A few seconds later, Y calls out to SE:

Y: SE, my star sign says I'm going to have a lucky week.

SE: Who said?

Y: My star sign.

SE: Oh, does it? Oh, isn't that interesting!

Yin was a fairly quiet student and these interactions with SE were the most significant observed during the monitored period. Of the four targeted students at Seaside, Yin's success and failure attributions to `ability' (Table 2) were least functional (equal lowest for success, highest for failure) and she was the only one of the four to consider success due to environmental factors (including luck) the highest of the four causes. When students receive indirect feedback of their skills (Yin's plotted points checked out) and direct acknowledgment of external factors (luck, cheating) their beliefs about the reasons for success and failure in mathematics may well be affected.

Conclusions and implications for teaching

The classroom observations strongly implicated several classroom factors which singly, or in combination, might influence students' beliefs about the reasons for success and failure in mathematics: teachers' and classmates' behaviours, the learning activities in which students engage, assessment associated with learning activities, and an emphasis on competition. The factors discerned provide partial explanations for the gender differences in attributional styles frequently reported in the literature.

Mathematical activities such as those in which the students were engaged are consistent with non-traditional mathematics classroom learning environments and with contemporary notions of effective mathematics learning. These and similar activities are to be encouraged. It would appear that when adopting such classroom activities an appreciation of the possible influence of the identified classroom factors on student's affective beliefs is also required.

Findings from the present study suggest that teachers might carefully consider:

* the membership composition of small groups engaged in cooperative activities
* appropriate recognition of individual efforts when devising assessment criteria associated with cooperative group endeavours
* their own and classmates' responses to students' successes and failures in competitive, skills-based activities and in formal assessment tasks

To maximise the potential of all students, mathematics outcomes in the affective domain demand equal attention to those afforded the cognitive domain.

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